REMARKS

The contents of the Office Action of February 4, 2004, have been carefully noted. The indication of allowability of claim 37 is noted with appreciation. Claims 18 and 29 have been amended only to define the subject matter of this invention with greater clarity, without altering their scope. Claim 37 has been amended to define a further novel feature of the invention. New claim 39 constitutes the previous version of claim 37 in independent form. Thus, claims 18-39 are pending and claim 39 is in prima facie allowable condition.

The prior art rejection of claim 18-36 and 38 under 35 USC §102 as being anticipated by WO96/25633 ('633 hereinafter) in view of US 3,927,659 to Blake et al. ('659 hereinafter) is traversed on several grounds.

Firstly, the rejection is legally unsustainable because it is stated to be under 35 USC §102((b) and is based on a combination of two references. A rejection under this section of the statute cannot be based on a combination of references. A new rejection under 35 USC §103, based on the same references would be a new ground of rejection that cannot be made final.

Substantively, the rejection is based on the view that all substantial features of the previous version of Claims 18 and 29 are disclosed in '633, except for the feature that the protected transparent window surface is transverse to the longitudinal axis. The Examiner has found the latter feature in '659 and maintains that it would be obvious to combine '659 with '633 in order to arrive at the claimed invention.

Claims 18 and 29 have been amended solely to clarify the structural features that help to distinguish the invention over the prior art, without restricting the scope of these claims prior art. In addition, Claim 37 has been amended to specify that the egress opening (outlet) is at the end of the chamber that is opposite to the surface to be protected. The location of the egress opening (outlet) is now defined in amended independent Claim 29 as being axially spaced from the surface to be protected towards the other end of the chamber (the end opposite to the surface. In the original claims, the "opposite end" position was defined in the claim 29 while a position "extended towards the [protected] surface was claimed in Claim 37.

The rejection is traversed because one skilled in the art would have no reason to combine the reference teachings in the manner proposed to support the rejection and even if the

combination were made, the resulting device would not conform to the application claims and would, moreover, be inoperative, or at least incapable of protecting the window.

In the explanation of the rejection, the Examiner asserts that '659 reference "teaches a reaction chamber". This is clearly incorrect. The '659 reference clearly does not describe or even imply a "reaction chamber," but rather discloses a tubular heat exchanger, described in the reference itself as an "energy conversion chamber" through which there is **no fluid flow** and in which **no reaction takes place**. There is neither an inlet, nor an outlet, nor a primary flow, nor a secondary flow, nor a working fluid, nor reactants.

In other words, the '659 reference is taken from an art that is totally unrelated to the field of the primary reference and of the present invention. The '659 reference belongs to a nonanalogous art that would net be consulted by one skilled in the art seeking to improve a reaction chamber powered by solar energy. For this reason alone, the rejection is unsupportable.

For the above reasons, the disclosure of the '659 reference is not relevant to the patentability of the present claims and there would be no incentive for one skilled in the

art to seek in the '659 reference any solution for "efficient protection of a surface in a **reaction** chamber".

Moreover, the modification of the structure disclosed in the '633 reference, invlolving replacement of the frustoconical or cylindrical window by the flat window of the '659 reference would be quite contrary to the teachings of the '633 reference in that it would prevent attainment of certain benefits contemplated in the '633 reference. Specifically, the window configurations disclosed in the '633 reference are chosen for obtaining "centrifugal force by which the mixture is drawn away from the inner window… whereby contact between the mixture and the window is eliminated…" ('633, p.5, l.15-18). In addition, the purpose of the frustoconical window construction is to cause the "pressure acting from within" to result "in compression stresses in the window."

Thus, if the window of the '633 reference were replaced by that of the '659 reference, the benefits mentioned above would be lost. It is well recognized that a rejection based on a combination of references is in error when modification of primary reference according to secondary reference would destroy the device of the primary reference for its intended purpose. *Ex parte Westphalen*, 159 USPG 507 (Bd. of App., 1967).

It can be further stated that, in view of the disclosed purpose of the frustoconical window of the '633 reference, that reference teaches away from replacement of that window with a flat window.

Moreover, as will be explained below, even if the frustoconical window of the '633 reference were replaced by the flat window of the '659 reference, the methos and device defined in the claims of the present application would not result. In fact, there is a serious question as to whether such modification of the device disclosed in the '633 reference would be operative.

Without limiting the scope of amended Claims 18 and 29, attention is drawn to the fact that they call at least for three principal constructive features:

First, the surface to be protected is disposed at one end of the reaction chamber, it is transverse to the longitudinal axis of the chamber and has a central area close to the axis, and periphery remote from the axis;

Second, the primary flow is introduced from the chamber periphery in a swirling manner and is

axially withdrawn through an outlet disposed close to the axis and axially spaced from the protected surface; and

Third, a secondary protective flow is introduced at the periphery of the protected surface and is directed along the protected surface towards the axis.

The operation of a reaction chamber having the above three features is described in the specification, at page 10, line 7 to page 12, line 5, with examples given on page 12. (The Examiner is respectfully requested to refer to that part of the specification, having in mind that the "vortex flow" described there is the "free vortex flow" of the claims).

To further aid an understanding of the contribution made by this invention, attached hereto as an Annex, and made a part of this response, is a description of the process that takes place in a device according to the invention.

The three constructive features allow obtaining of the following important hydrodynamic effects:

A) Organization of the primary flow of reactants and the flow of reaction products through

the reaction chamber such that the flows "approximate a free vortex flow characterized by a negative pressure gradient increasing towards the axis". (note that the pressure itself is steeply falling towards the axis, while the negative gradient grows). In particular, such flow with such gradient is **possible** because the second feature allows (a) substantial radial component in the vortex flow (from the chamber periphery to the axial outlet), and (b) allows a free vortex flow to develop in the space between the chamber periphery and the axis, and between the protected surface and the outlet.

As it is known in the art, the free vortex flow conserves the angular momentum of the fluid, e.g. the product $u \times r = const$ where u is the tangential velocity and r is the radius of rotation. Consequently, when a fluid particle is drawn to the center (axis) of the vortex, its tangential velocity increases inversely proportional to the radius, $u \sim 1/r$. But according to the law of energy conservation (Bernoulli equation in the case of fluids, no viscous losses),

$$P + \frac{\rho v^2}{2} = const$$

where P is the static pressure, v is the linear velocity and ρ is fluid density. Considering that u is the main component of the full velocity v, it is clear that v grows towards the axis approximately as u, $v \sim 1/r$ while the static pressure steeply falls towards the axis, $P \sim -\frac{1}{r^2}$. The pressure gradient along the radius falls even steeper, as the derivative of $1/r^2$, $\Delta P \sim -\frac{1}{r^3}$ (see p.10, l.19 of the spec. The sign is "minus" because a fluid particle approaches the axis in a direction opposite to the radius). This gradient tends to accelerate the fluid towards the vortex axis, but for fluid particles in the vortex itself the accelerating action of the pressure gradient is essentially balanced by the centrifugal force of their rotational motion. However, the action of the pressure field and its gradient goes beyond the free vortex, as shown below.

The above laws are true, within certain accuracy, when the internal fluid friction (viscosity) and energy dissipation are negligible. The free vortex

flow in amended Claims 18 and 29 is "approximated" in the sense that there are walls (boundaries) influencing the flow (through associated friction) such as the chamber walls and the protected window. However, the influence of these boundaries is negligible in the internal space of the chamber, between the protected surface and the outlet, so that the vortex flow there **preserves the feature which is essential for the invention**, namely the "negative pressure gradient increasing towards the axis".

B) Stabilization (non-separation) of the secondary protective flow substantially on the entire protected surface, which is the purpose of the invention. This is achieved by the combination of:

- the **first** and the **third** constructive feature (the protective flow is introduced at the periphery of the protective surface towards the axis); and

- the effect (A) above.

The synergy between the protective flow and the primary flow is explained in the spec (p.10, 1.27 to

p.11, l.18). We shall emphasize here that the pressure field of the primary flow (the free vortex flow) acts outside the primary flow proper and accelerates the adjacent protective flow towards the axis. The protective flow is purposefully introduced in the **direction of decreasing pressure**, towards the axis, so that the gradient created by the primary free vortex flow would further accelerate it towards the axis. Thus, the primary flow helps to prevent separation of the protective flow from the protected surface (p.11, l.22-25). On the contrary, if the protective flow were directed opposite to the pressure gradient, it would be decelerated, destabilized and easily separated from the protected surface.

Analysis of the cited Prior Art

As will now be seen, even if the frustoconical window of the '633 reference were replaced by the flat window of the '659 reference, the claimed method and device would not be created.

With regard to the second constructive feature noted above, the '633 reference discloses the technical feature "introducing the flow in a whirling manner" but does not

disclose the feature of "axially withdrawing through an outlet disposed close to the axis". Rather, the primary flow in the '633 reference is withdrawn at (31) which is near the periphery of the chamber and more or less at the same radial distance from the axis of the chamber as the ingress openings (27). Such disposition does not allow the swirling flow of the '633 reference to have a significant **radial** component. This disposition is not "simply a matter of design choice", as the Examiner alleges; but rather the egress (31) in the '633 reference cannot be moved to the axis by a simple design choice (i.e. without re-designing the whole chamber) because the axial region in the '633 reference is **occupied** by the frusto-conical window (6). Furthermore, the Examiner has cited no prior art evidence supporting this "design choice" theory.

It is the withdrawing of the primary flow through an **outlet close to the axis** that allows the primary flow of Claim 18/29 to have a significant radial component and to approximate a free vortex flow with the desired negative pressure gradient steeply rising towards the axis, like a cyclone (p.10, l.14-21 of the spec). This feature is not disclosed in the '633 reference.

The above alone demonstrates that at least the feature "axially withdrawing through an outlet close to the axis" is not disclosed in the applied references and thus patentably distinguishes the amended Claims 18 and 29 from the prior art '633 reference cited by the Examiner.

Another important feature of the primary flow in the '633 reference is that it is **bounded** by an inner frusto-conical surface (6) which does not allow the whirling flow in the '633 reference to develop a radial component. Furthermore, the inner surface also prevents acceleration of the flow in the circumferential direction because of the boundary layer and the friction associated with that surface. Where a free vortex flow would have velocity v growing as $v \sim 1/r$, the '633 reference puts a wall with friction preventing velocity growth and angular momentum conservation. Indeed, the flow in the '633 reference is helical (or vortex), but a helical flow bounded in an annular space as in the '633 reference is known in the art to rotate approximately as a solid body (barring the axial component). Such flow does not provide a negative pressure gradient steeply rising toward the axis.

Thus, the primary flow in the '633 reference, contrary to the Examiner's opinion, does **not** approximate a **free** vortex flow in that it is not free but bounded and has no significant

radial component. Consequently, it does not provide the negative pressure gradient required in amended Claims 18/29. This is due to the constructive differences (side egress and inner surface) outlined above.

With regard to the third principal feature, there is not reason to assume that the secondary protective flow in the '633 reference would be directed to the central area of the protected surface, even assuming replacement of window 6 by a flat window. In fact, and this is important to note, it is not clear what path this protective flow would follow because there is no disclosure in the '633 reference of an outlet for this protective flow. Since the only outlet disclosed therein is a vent 32 at the top of the chamber, it would appear the the protective flow would be directed radially outwardly at the top of the chamber and could not sweep either window 6 or, more clearly, a flat windo at the bottom of the chamber. Of equal importance is that the secondary flow in the '633 reference is directed **opposite** to the existing pressure gradient of the primary flow. (Note that the pressure gradient in the chamber of the '633 reference is directed from the ingress 27 to the egress 31 which is opposite to the secondary flow jet from the annular nozzle 35). For this reason, the secondary flow in the '633 reference is easily destabilized

and separated from the surface, which **destroys** its protective function. In order to keep the flow non-separated, the secondary flow rate must be extremely high, commensurate with the primary flow rate. Thus, the choice of the secondary flow rates in the '633 reference is restricted.

On the contrary, the secondary flow in Claims 18 and 29 is directed towards the decreasing pressure. Thus, the pressure gradient of the primary flow "pulls the secondary flow… to the center as a boundary layer without separation" (p.4, l.18-19 of the spec, also p.11, l.22). This allows advantageously for the protection of the surface by the secondary flow with a significantly lower flow rate than that of the primary flow (p.11, l.25 and further). This is an unexpected result which cannot be obtained in the '633 reference by routine experimentation and optimization of the flow rates, as the Examiner alleges. Simply put, in the '633 reference it is not possible to reduce the secondary flow rate by an order of magnitude below the primary flow rate and still obtain protection of the window.

As explained in the specification of the present application (p.10, l.7-p.11, l.25), the invention of amended Claims 18 and 29 provides for synergism between the primary and secondary flows Such synergism is not found in the prior

art. Rather, the '633 reference teaches away from such synergism by the fact that its secondary flow is directed opposite to the pressure gradient created by the primary flow.

Thus, device disclosed in the '633 reference, even if modified in the manner proposed by the Examiner, does not contain at least three principal constructive features of the amended Claims 18 and 29, does not provide an indispensable hydrodynamic effect related to these features (free vortex flow with the required pressure gradient), and teaches away from synergism between the protective flow and the primary flow.

Thus, even if a person skilled in the art would try to combine the '633 and '659 references, he will not arrive at the claimed invention, at least because neither of those references teaches a primary flow organized as a free vortex flow, or a synergism of the protective flow with the primary flow.

In view of the above, it is respectfully submitted that amended Claims 18 and 29 are patentably distinct from the '633 and '659 references, or any combination thereof. Claims 19-28 and 30-38 should be considered patentable at least in view of their dependency from respective ones of claims a8 and 29.

It is therefore requested that the prior art rejection presented in the previous action be reconsidered and withdrawn, that claims 18-38 be allowed along with already allowable claim 39, and that the application be allowed.

If the above amendment should not now place the application in condition for allowance, the Examiner is invited to call undersigned counsel to resolve any remaining issues.

Respectfully submitted,

BROWDY AND NEIMARK, P.L.L.C.
Attorneys for Applicant

By Jay M. Finkelstein

Jay M. Finkelstein
Registration No. 21,082

JMF:mch
Telephone No.: (202) 628-5197
Facsimile No.: (202) 737-3528
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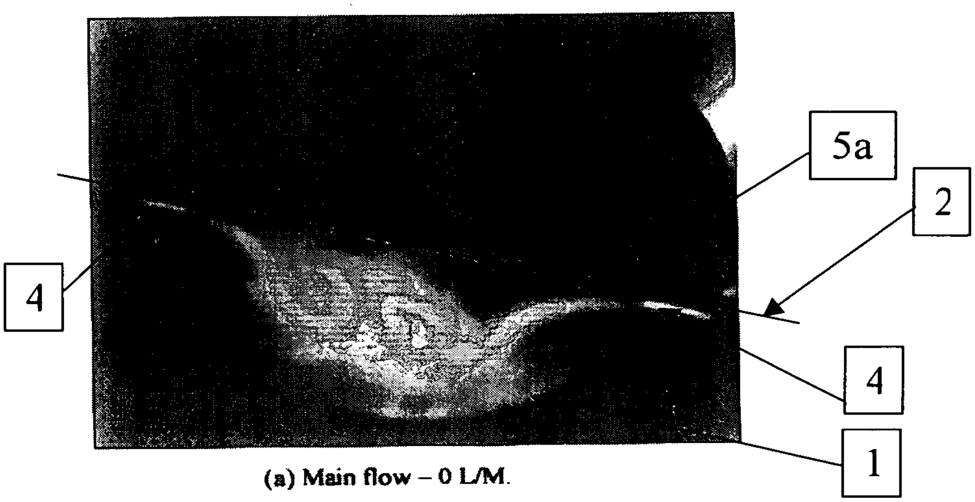
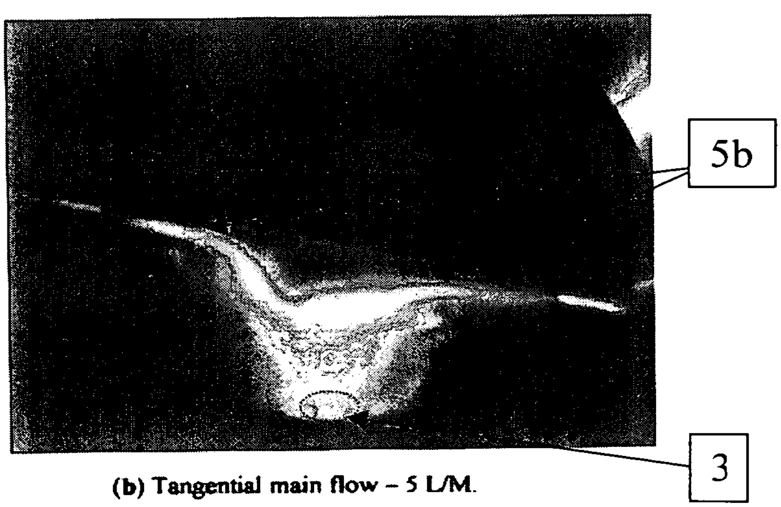
Reaction chamber with solar window protected by a thin secondary flow

The following pictures show a cylinder reaction chamber (1) closed by a flat transparent solar window (2) transverse to the cylinder axis. The bottom of the chamber is conical. A thin vertical planar laser beam is directed into the reaction chamber through the solar window. Smoke particles are introduced with the flow and are illuminated when they are located the beam plane (white "clouds"). As a result, we see a cross-section of the reaction chamber with white traces indicating the flow path, on dark background. The view point of the camera was above the solar window and aside from the cylinder, that's why the window is seen somewhat tilted.
The main flow (primary flow) is introduced into the chamber in swirling manner (tangentially) from peripheral inlets under the solar window and is withdrawn downwards through a central outlet (3) at the conical bottom. The primary flow <u>is not charged with smoke</u> and is not directly seen in the pictures.
The protective flow (secondary flow) is introduced into the chamber radially from peripheral inlets (4) adjacent the solar window (2). The secondary flow is directed along the solar window, towards its center. The secondary flow is charged with smoke and is visible in the pictures.



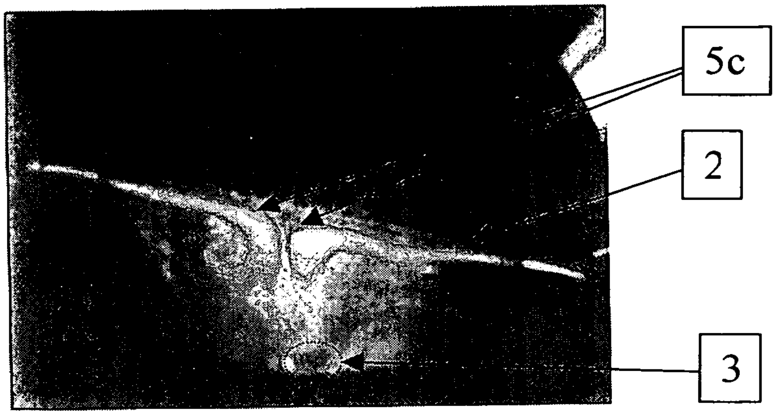
(a) Main flow – 0 L/M.

In picture (a), there is no primary flow. The secondary flow (5a), with rate 2 liter/min, is immediately <u>detached</u> from the window surface (2) upon entry in the reactor chamber.



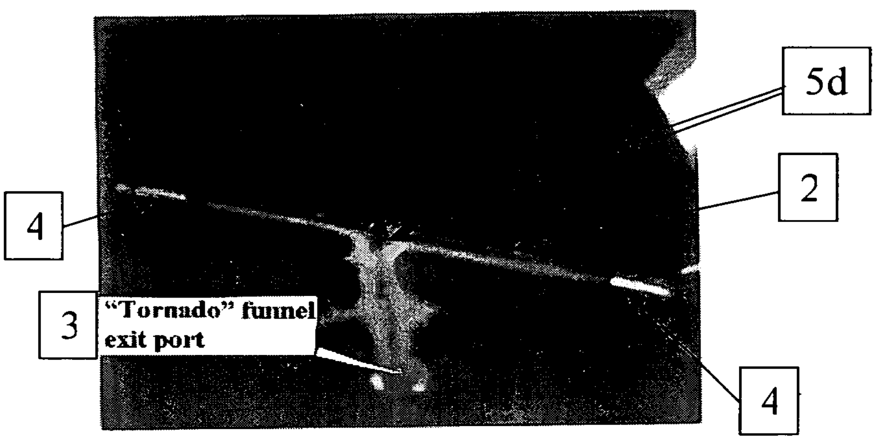
(b) Tangential main flow – 5 L/M.

In picture (b), weak primary swirling flow is introduced at rate 5 l/m. The secondary flow is the same as above – 2 l/m, and is not changed further. The flow (both primary and secondary) is withdrawn through the bottom outlet (3) in the center, whereby free vortex flow is formed. The vortex is still weak but its negative pressure gradient directed towards the axis already helps the secondary flow (5b) to stay attached half-way to the window center.



(c) Tangential main flow – 10 L/M.

In picture (c), the primary swirling flow is stronger, 10 liter/min, and the negative gradient of the free vortex flow is sufficient to keep the secondary flow (5c) attached all the way to the axis.



(d) Tangential main flow – 15 L/M.

In picture (d), the primary swirling flow is even stronger, 15 liter/min, the free vortex flow is a veritable "tornado". The negative pressure gradient is so strong that the secondary flow (5d) is pulled to the axis like taught rope parallel to the window. The straight form of the secondary flow shows that there is no flow component perpendicular to the window and thus no solid particle from the primary flow can reach the window. The window is perfectly protected, substantially over all its area – and that with constant secondary flow rate 2 l/min. In this test, the secondary flow rate is only 2/15 ~ 13% of the primary flow rate.

Due to the inventive synergism, the proportion of the secondary flow may be even smaller, 0.5 / 20, or 2.5% (page 12, line 8-9 of the spec).